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THE LASI EXPERIMENTAL ENGINEERED WASTE BURIAL FACILITY:  
DESIGN CONSIDERATIONS AND PRELIMINARY PLAN

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INTRODUCTION

The LASI Experimental Engineered Waste Burial Facility is a part of the National Low-Level Waste Management Program on Shallow-Land Burial Technology. It is a test facility where basic information can be obtained on the processes that occur in shallow-land burial operations and where new concepts for shallow-land burial can be tested on an accelerated basis on an appropriate scale. The purpose of this paper is to present some of the factors considered in the design of the facility and to present a preliminary description of the experiments that are initially planned. This will be done by discussing waste management philosophies, the purposes of the facility in the context of the waste management philosophy for the facility, and the design considerations, and by describing the experiments initially planned for inclusion in the facility, and the facility site.

WASTE MANAGEMENT PHILOSOPHY

For properly operated (no surface spills, no broken packages, and proper administrative controls) low-level waste burial facilities, the primary modes of radioactive contamination have been through leaching and transport of radionuclides by water and by the release of radioactive gases to the atmosphere.<sup>1,2</sup> Because low-level radioactive waste burial sites may also contain hazardous materials, they must also be designed and engineered to prevent the escape of these components into the environment. Emphasis here will be on the problems associated with the generation and possible release of contaminated solutions from the facility intended to retain and control the waste form. The solutions can arise from

interactions of infiltrating water with the waste, or they may be part of the waste.

Waste management philosophies can be expressed in two ways: solve the problem once it happens, or prevent the problem in the first place. Since the purpose of the experimental waste burial facility is to demonstrate and substantiate new techniques, the waste management philosophy adopted is based on preventing problems rather than solving them. Three general waste management philosophies, expressed in terms of prevention rather than correction, are outlined in Table 1.

The guaranteed 100% safe philosophy is unrealistic from a technical and cost viewpoint, but may have some political advantages. Planned dispersion, from a general political point of view, is probably not acceptable. However, this is a viable alternative if dispersion can result in a concentration level that is innocuous. State-of-the-art containment is probably the best approach from all

Table 1. WASTE MANAGEMENT PHILOSOPHIES

**GUARANTEED 100% SAFE**

Engineer the waste disposal facility so that water cannot reach the emplaced waste, thereby eliminating the possibility of contaminants being mobilized. Water from the waste degradation or liquids contained in the waste that enter through the packaging and other preventative measures will be channeled, collected and passively treated.

**STATE-OF-THE-ART CONTAINMENT COMBINED WITH ENGINEERED CHANNELLING OF THE EFFLUENT**

Recognize that some water is going to get into the burial pit or that there is going to be some leakage from liquid wastes. Design the pit so that infiltrating water is diverted and collected before it can reach the emplaced wastes. As a backup, and to manage liquids in or generated in the waste, engineer the system so that if any leachate or effluent is formed, it can be collected and properly treated with a passive system.

**CONTROLLED DISPERSION**

Provide specific access channels for the water so that contaminants are mobilized and dispersed in a controlled manner. If liquid waste forms are present, their release is controlled similarly.

viewpoints. It is the most honest approach because it is probably impossible to guarantee 100% containment or absolute isolation from water. With an understanding of the processes that occur in mobilization and migration of contaminants, based on quantitative experimental results, this approach can also be made politically acceptable. State-of-the-art containment combined with engineered channeling of the discharge is the waste management philosophy to be used in the design of the experimental engineered waste burial facility.

In discussing waste management philosophies we must also consider the possible intrusion of plants and animals into the buried waste after closure with the resulting mobilization or transport of contaminants out of the disposal area into the environment. In this situation we must consider two alternative waste management philosophies, guaranteed 100% safe from plant and animal intrusion or state-of-the-art closure with detailed monitoring to detect intrusion. Again, in this case, state-of-the-art closure is the philosophy adopted because the guaranteed 100% safe waste management philosophy is not realistic from either a technical or cost viewpoint.

#### PURPOSES OF THE EXPERIMENTAL ENGINEERED WASTE BURIAL FACILITY

State-of-the-art containment combined with engineered channeling of the discharge can only be successful if enough experimental results are available that the waste disposal facility can be constructed in a completely engineered environment. The experiments to be done in this facility will provide this collection of data.

To clarify the purposes of the facility the concept of a completely engineered environment must be expanded a little. In an engineered environment, data on migration and mobilization of contaminants, interaction of the contaminants with the fill material, water infiltration through the cap system, and through the disposal facility walls or liner systems, leakage rates from engineered containers, and the general chemistry and hydrology of the system are used to design the waste disposal facility so that liquid movement can be predicted, and so that the amount and composition of any leachate or liquid in the system is known. Any liquid formed will be passively treated to minimize release to the environment. For a waste management philosophy of controlled release, in addition to the above, the release rate and the composition of the released material will be controlled.

A summary of the general purposes of the experimental engineered waste burial facility is given in Table 11. This list covers the full range of experiments that are necessary if future shallow-land burial facilities are to be constructed in a completely engineered environment. The emphasis is to obtain experimental results that can be used

Table 11. GENERAL PURPOSES OF EXPERIMENTAL WASTE BURIAL FACILITY

TEST METHODS FOR CONSTRUCTING AND OPERATING WASTE DISPOSAL FACILITIES

- Determine need for liners.
- Evaluate burial pit liner systems, if needed.
- Evaluate burial pit cap systems.
- Evaluate backfill materials.
- Evaluate burial pit drain systems.

DESIGN AND TEST MONITORING SYSTEMS TO MEASURE BURIAL PIT PERFORMANCE

- Measure infiltration rate of water into the burial pit.
- Measure leach rate and leachate composition in burial pit.
- Measure water and leachate movement out of the burial pit.
- Monitor heat flow into and out of the burial pit.
- Measure evaporation and transpiration of water.

CONTROL CLIMATIC CONDITIONS AT THE BURIAL PIT

DETERMINE EFFECT OF BIOLOGICAL ACTIVITY ON MATERIAL CONTAINED IN THE BURIAL PIT

DETERMINE SCALING FACTORS TO BE USED IN BURIAL PIT DESIGN

EVALUATE BIO-BARRIERS

EVALUATE ARID SITE CLOSURE PROCEDURES

EVALUATE REMEDIAL ACTION PROCEDURES FOR ARID SITES

in the design of future low-level waste disposal facilities. In addition, the experimental results can be used to validate models for predicting long-term behavior of the facilities and will therefore be useful in convincing the public about the safety of the facility and design.

DESIGN CONSIDERATIONS

The experiments outlined in Table 11 involve hydrological, chemical, mechanical, and biological factors. In order to separate these various factors in the experiments and to extrapolate the experimental results to actual facilities, experiments should be performed on several different media.

Three general scales have been chosen for experiments in this facility: isolated variable experiments, intermediate scale experiments, and integrated experiments. The isolated variable experiments will be performed in caissons or lysimeters, which will be more completely described in the section on the initial experiments. The intermediate scale experiments will be performed in experimental burial pits about 15 feet on a side and of variable depth. The integrated experiments will be performed in burial pits with dimensions typical of those encountered in commercial low-level radioactive waste disposal facilities.

Although the isolated variable experiments are quite chemical in nature, the intermediate scale experiments are designed to provide information on mechanical effects and a combination of mechanical and chemical effects. The leachate-liner-fill interactions are both mechanical and chemical, while the gas channeling and collection and the burial pit drainage systems are more mechanical. The integrated experiments will address such large scale mechanical problems as pit settlement, cap cracking, and the effects of the pit filling operation and backfilling and capping on the liner and drain systems.

Another important factor in the design considerations is the desired capability of accelerated testing of the experimental system performance. Since the majority of the problems results from interactions of the system with water, accelerated testing will be done by adding extra water to the system. This will also give information on the time dependence of weathering phenomena which will again be useful to substantiate models for shallow-land burial systems.

#### INITIAL EXPERIMENTS PLANNED FOR THE FACILITY

The range of experiments possible in the LASI Experimental Engineered Waste Burial Facility and an indication of an appropriate scale for these experiments have been presented in Table II and the text. Given the large number of materials and configurations possible for these experiments, the difficult task is selecting the experiments to be done and the order in which they should be done. In our case, specific requirements of the National Low-Level Waste Management Program on Shallow-Land Burial Technology have made the choice easier. Initial experiments will be in the areas of migration barriers, remedial action testing, and site closure, and the eventual intrusion barriers.

Migration barriers for both water and radionuclide transport will be evaluated in isolated variable experiments. The isolated variable studies will be performed in experiment clusters, each of which consists of six experimental caissons clustered around a central access and instrument caisson. The instrument and access caissons will be about 9 to 10 ft (about 3 m) in diameter and deep enough

for the experiment being performed. The experiment caissons can be any size up to the same size as the central caisson or can be larger if used in place of two smaller caissons. The access caisson will allow samples to be taken in a horizontal direction in any of the experimental caissons at any elevation without disturbing the surface of the caisson or allowing vertical access by water to the packing material.

The use of multiple experimental caissons around a central instrument and access caisson will allow a large number of separate experiments per unit. The caisson provides isolation of the experimental areas and also prevents the horizontal influx of water, allowing more precise control of the environment in each of the experimental areas. Different types of fill materials can be used in these caissons. The experiment cluster described here is a modification of a similar design by Phillips et al.<sup>3</sup>

Based on previous work on this program,<sup>4,5,6</sup> the most promising candidate natural barrier materials for water and radionuclide migration will be chosen for testing. A liner of this chosen material will be placed in a caisson and then backfilled. Appropriate tracer materials will be placed in the fill materials. Sufficient artificial rainfall will be applied to the caisson to mobilize the tracer and transport them to the fill-liner interface. The retarding effect of the liner material on water and radionuclide transport through the liner will be measured. As many different liner materials as the budget of the program allows will be tested.

Monitoring methods will include gamma probes to measure the movement of the tracer material, neutron probes to measure the movement of water independent of the tracer, and temperature and bulk density measurements. In addition, samples of leachate solution will be collected with porous cups.

The remedial action testing experiments are designed to provide solutions to possible problems that might occur in a closed shallow-land burial facility in an arid environment. These problems include surface water infiltration, surface erosion by wind or water, contaminant uptake by plants and animals, and upward migration of radionuclides due to moisture cycling.

Several configurations of integrated cap system will be constructed and tested. These integrated cap system will be multifunctional and will be designed to prevent water infiltration, plant infiltration, and wind and water erosion. Measurements will be made on the experiments so that the reasons for the success or failure of an integrated cap system will be known and documented. These experiments will be performed on the intermediate scale.

The upward migration experiments will be performed in a smaller individual caisson. Tracer materials will be placed in typical fill materials at a depth determined to be in the region of moisture cycling. The system will be monitored to determine if tracer material is brought to or near the surface of the caisson due to moisture cycling.

The arid site closure experiments will be designed to field test, on an appropriate scale, methods for closing shallow-land burial facilities in an arid environment. These tests will include both the physical methods used to close the facilities and the monitoring methods to evaluate and confirm the performance of the closure procedures used. The purpose of these experiments is to provide field tested, well documented procedures for arid site closure so that the problems described in the remedial action testing section are anticipated and prevented while the site is operational and being closed.

These experiments will be similar to but distinct from the remedial action testing experiments. In these experiments, all phases of burial pit operation can be considered so that problems like pit subsidence can be approached early in the closure procedure. They will consist of complete model burial pits constructed on the intermediate scale. They will have liners, drain systems, caps, and appropriate monitoring systems to evaluate their performance.

The biological intrusion barrier experiment will be designed to field test trench cover configurations that will prevent the growth of deep rooted plants and the intrusion of burrowing animals into the buried waste materials. A variety of cover configurations will be tested in small lysimeters (about 1 ft in diameter) and on the intermediate scale. The cover configurations to be tested consist of various combinations and depths of soil and richards such as cobble, clay, and backfill.

#### SITE DESCRIPTION

The LASL Experimental Engineered Waste Burial Facility will be located on a mesa top on DOE land in Los Alamos County, New Mexico. The 20-acre site is about 2 miles west of the active low-level radioactive waste disposal facility for the laboratory. The soils and geology at both sites are similar.<sup>7,8</sup> The soils are of the Buckhorn Series, which consists of a surface layer of brown sandy loam, or loam, and 10 cm thick with a subsoil of reddish brown clay, gravelly clay, or clay loam about 20 cm thick. The depth to talus bedrock varies from 10 to 50 cm. The native vegetation is mainly piñon pine, one-sided juniper, scattered ponderosa pine, and a few shrubs.

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## REFERENCES

1. Panel on Land Burial, Committee on Radioactive Waste Management, Commission on Natural Resources, NATIONAL RESEARCH COUNCIL, "The Shallow-Land Burial of Low-Level Radioactively Contaminated Solid Wastes," National Academy of Sciences, Washington, DC (1976)
2. D. G. Jacobs, J. S. Epler, and R. R. Rose, "Identification of Technical Problems Encountered in the Shallow-Land Burial of Low-Level Radioactive Wastes," ORNL/SUB/13619/1 (1980)
3. S. J. Phillips, A. C. Campbell, M. D. Campbell, G. W. Gee, H. H. Hooper, and K. O. Schwarzmiller, "A Field Test Facility for Monitoring Water/Radionuclide Transport Through Partially Saturated Geologic Media: Design, Construction, and Preliminary Description," PNL-3226 (1979)
4. D. E. Daniel and R. E. Olson, "Geotechnical Aspects in Design of Disposal Sites for Low-Level Radioactive Wastes," Geotechnical Engineering Report GR80-6, The University of Texas, Austin, Texas (1980)
5. M. Pertusa, "Materials to Line or to Cap Disposal Pits for Low-Level Radioactive Wastes," Geotechnical Engineering Report GR80-7, The University of Texas, Austin, Texas (1980)
6. E. S. Takamura, "Disposal of Low-Level Radioactive Wastes: Alternate Methods and Improvements to Shallow-Land Burial," EHE-79-04, Environmental Health Engineering, University of Texas at Austin (1979)
7. J. W. Nyhan, L. W. Hacker, T. E. Calhoun, and D. L. Young, "Soil Survey of Los Alamos County, New Mexico," LA-6718-M (1978)
8. M. A. Rogers, "History and Environmental Setting of LAMP Near-Surface Land Disposal Facilities for Radioactive Wastes (Areas A, B, C, D, E, F, G, and H)," LA-6848-M, Vol. 1 (1977)